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STATMOOR - A SINGLE-POINT MOORING STATIC ANALYSIS PROGRAM.(U)
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TN NO: N-1634

TITLE: STATMOOR – A SINGLE-POINT MOORING STATIC ANALYSIS PROGRAM

AUTHOR: J. V. Cox

DATE: June 1982

SPONSOR: Naval Facilities Engineering Command

PROGRAM NO: YF59.556.091.01.403

TECHNICAL NOTE

NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

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METRIC CONVERSION FACTORS

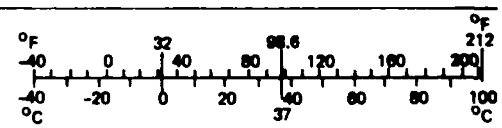
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TN-1634	2. GOVT ACCESSION NO. AD-A119995 DN787011	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) STATMOOR – A SINGLE-POINT MOORING STATIC ANALYSIS PROGRAM		5. TYPE OF REPORT & PERIOD COVERED Not final; Aug 1981 – Apr 1982 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. V. Cox		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS NAVAL CIVIL ENGINEERING LABORATORY Port Hueneme, California 93043		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62759N; YF59.556.091.01.403
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Facilities Engineering Command Alexandria, Virginia 22332		12. REPORT DATE June 1982 13. NUMBER OF PAGES 39
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS (of this report) Unclassified 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Moorings, single-point moorings, wind forces, current forces, mooring analysis computer program, hawser loads.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

STATMOOR is a static mooring analysis program written in BASIC language and is one program in a hierarchy of programs developed at the Naval Civil Engineering Laboratory for mooring analysis. STATMOOR analyzes the static response of a single-point moored vessel and hawser. The MENU arrangement of the program lends itself to a user-oriented conversational mode. The user has the option to enter, review, edit input, and obtain

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Naval Civil Engineering Laboratory
STATMOOR – A SINGLE-POINT MOORING STATIC ANALYSIS PROGRAM, by J. V. Cox
TN-1634 39 pp illus June 1982 Unclassified

1. Current forces 2. Conversational mode program I. YF59.556.091.01.403

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CONTENTS

INTRODUCTION

The Naval Facilities Engineering Command's (NAVFAC) mission includes the design and construction of fixed ocean facilities. To support this aspect of the mission, the Naval Civil Engineering Laboratory (NCEL) is developing a hierarchy of mooring analysis programs, which include both static and dynamic analysis. This report describes the use and contents of STATMOOR, which analyzes the static response of a single point moored vessel and hawser. It calculates the hawser load, hawser angle, and ship angle for steady current, wave, and wind loads. Wind load estimates are considered to be accurate; current and wave loads are in a preliminary form and merit further refinement.

The program is written in a conversational mode which is described in the operating section. The benefits and extensions of this work regarding Navy mooring applications are discussed later. The equations used in STATMOOR for the current, wave, and wind loads on the ship are in Appendix A. Appendix B contains a program listing, operation flow chart, and example printout.

OPERATION

The information in this section is overviewed in the explanation page of the program (Appendix B), but is described in more detail here.

Master Menu Options

The program is menu driven to lend to its user oriented conversational mode. The master menu allows the user to access the various program options. When the following master menu is presented the user is prompted to enter the number of the option choice. Options 1 through 7 return control to the master menu after execution (as diagrammed in Appendix B).

1. Input vessel characteristics.
2. Input environmental conditions.
3. Review/edit vessel characteristics.
4. Review/edit environmental conditions.
5. Calculate.
6. Tabular output.
7. Graphic display.
8. Exit program.

Enter Number of above choice? __

1. Input Vessel Characteristics - Allows the user to enter information about the vessel by presenting the user with a series of questions/choices. The answers provide the necessary input.

2. Input Environmental Conditions (Similar to Option 1) - Allows the user to enter information about the environmental conditions (current, wave, and wind).

3. Review/Edit Vessel Characteristics - Allows the user to review and change any of the vessel characteristics.

4. Review/Edit Environmental Conditions - Allows the user to review and change any number of the environmental conditions. [NOTE: Options 3 and 4 allow parametric studies without redundant input.]

5. Calculate - Performs the calculations of the forces on the ship and the equilibrium conditions. Some loading conditions yield two stable solutions, so the user has the option to search for multiple stable solutions. Another user option is the ability of the program to determine the direction of current loading (within 10 degrees) which causes the maximum hawser load. A brief summary of the output can either be printed or displayed on the video.

6. Tabular Output - Allows the user to obtain either printed or video output. Video output consists of a table of force coefficients, a table of the individual environmental forces on the vessel, and equilibrium conditions (hawser load, hawser angle, and ship angle). Printed output consists of all the video output plus all the vessel and environmental input (see Appendix B).

7. Graphic Display - Gives a graphic display of the incident current, wave, and wind directions as well as equilibrium angle of the ship and the hawser.

8. Exit Program - Exits the program and returns control to the operating system.

Input

The input consists of numerical values, letters, and descriptions, prompted by the program:

- Numerical values must be typed with no alpha characters (e.g., no letters).
- Letters are used as input to subjective questions and to control the flow of the program. At several points the program asks a question followed by the characters (Y/N), which means the user should enter Y for yes or N for no.
- Descriptions are entered in the input sections of the program to document the problem being solved. Alpha and numeric characters can be used in the description.

All input must be followed by the return key.

Angle Conventions and Coordinate System

There are two angle conventions in the program, absolute and local. The fixed, absolute angle is zero at twelve o'clock and increases counter-clockwise. It is used to enter the incident angle of the environmental

loads and output the equilibrium angles of the ship and hawser. The local angle rotates relative to the vessel direction. Head loading is zero degrees and the angle increases counterclockwise. The local angle is used for calculation of loads and output in the force table. The local coordinate system is also relative to the vessel. The positive X-axis is at the local angle of 180 degrees, toward the stern; positive Y-axis is at the local angle of 270 degrees, toward the starboard. The local angle convention and coordinate system are shown in Figure 1.

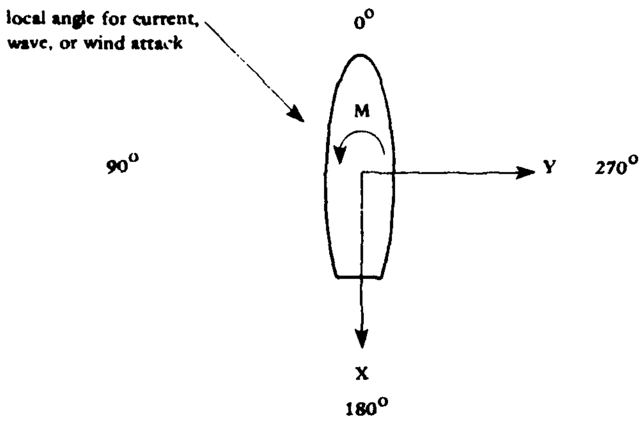

Figure 1. Local angle and coordinate system.

Computations

STATMOOR considers steady current, wind, and wave loads. Each of these environmental loads is broken into a longitudinal force, lateral force, and yaw moment. Wind load computations consider the wind gradient as well as the vessel geometry (vessel group). The wind loads are based on recommendations from Reference 1. The current loads include form, friction, and propeller drag, and are based on References 2 and 3. The wave drift loads consider the wave spectrum and drift force operators and are based on References 2 and 4 through 8. The equations are presented in Appendix A.

BENEFITS AND EXTENSIONS

STATMOOR was written to demonstrate the feasibility of conversational mode programs and is one of a hierachy of programs developed for mooring analysis at NCEL. Its simplicity and ease of input allow it to be used with little or no instructions.

STATMOOR is unique for the following reasons:

(1) First program to incorporate recently developed wind load information (Ref 1).

(2) Conversational to the extent it can be confidently used with little or no training.

(3) Easily adaptable to most desk top computer.

The use of this computer program has advantages over both hand calculations and tabulated results, as outlined below:

(1) Reduced calculation time (especially to determine worst case loadings).

(2) Less chance of numerical error.

(3) No chance of procedural error.

(4) Ease of parametric studies.

(5) Ability to quickly check the effect of input uncertainties on the results.

(6) More variables can be considered than are practical for tabulated results.

(7) Advances in state-of-the-art can be incorporated with ease.

In its present form the output equilibrium condition can be used to enter more sophisticated computer programs which do not easily converge on the static solution or to enter programs which determine the response of the complete mooring.

A conversational program could be expanded to include design aids, such as ultimate strength as a function of cable diameter relationships (Ref 9). The result would be a very cost-effective tool for preliminary design and cost estimating. With further extensions this type of program could become a computer-based mooring design manual, as an alternative to the present DM 26 (Ref 10).

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Appendix A

EQUATIONS

This section of the report reviews the equations used in STATMOOR for the current, wave, and wind loads on the ship. The various experiments and analytical methods examined for this report produced a large scatter in the forces induced on a moored ship by currents and waves. The user must keep this uncertainty in current and wave forces in mind. The wind forces are based on the recommendations in Reference 1 and are as accurate as the user's knowledge of the actual wind environment.

CURRENT LOADS ON VESSELS

Currents produce longitudinal (F_{xc}) and lateral forces (F_{yc}) as well as a yaw moment (M_c) about the center of gravity of the vessel. Figure A-1 shows the scatter obtained for lateral current loads by various methods in an NCEL study (Ref 11).

Longitudinal Current Loads

The longitudinal force consists of forces due to form, friction, and propeller drag as follows:

$$F_{xc} = F_{x\ form} + F_{x\ friction} + F_{x\ prop} \tag{A-1}$$

Pressure drag, commonly called form drag, is characterized by separation and the formation of a downstream wake. Form drag is given by the following equation:

$$F_{x\ form} = 1/2\ \rho_w V_c^2\ C_{xcb}\ A_b\ \cos^3\theta_c \tag{A-2}$$

where ρ_w = mass density of water (1.9876 slug/ft^3)

V_c = average current speed (ft/sec)

C_{xcb} = longitudinal current form drag coefficient = 0.1 (NCEL estimate)

A_b = end-projected area below the waterline of the vessel = Beam x Draft (ft^2)

θ_c = local angle of the current

Skin friction drag is the resultant of tangential shear stresses due to viscosity and velocity gradients at the boundary surface. Friction drag is given by the following equation (Ref 2):

$$F_{x\ friction} = 1/2\ \rho_w V_c^2\ C_{xca}\ S\ \cos^3\theta_c \qquad \text{(A-3)}$$

where C_{xca} = longitudinal skin friction coefficient
$= 0.075/(\text{Log } R_n - 2)^2$

R_n = Reynolds Number = $V_c\ L\ \cos\theta/\nu$

L = waterline length of the vessel (ft)

ν = kinematic viscosity of water (1.4×10^{-5} ft²/sec)

S = wetted surface area (ft²)
$= (1.7\ TL) + (35\ D/T)$

T = draft of vessel (ft)

D = displacement of ship (long tons)

Propeller drag is the form drag of the vessel's propeller with a locked shaft. Propeller drag is given by the following equation (Ref 4):

$$F_{x\ prop} = 1/2\ \rho_w V_c^2\ A_p\ C_{prop}\ \cos^3\theta_c \qquad \text{(A-4)}$$

where A_p = propeller expanded (or developed) blade area (ft²)

C_{prop} = propeller drag coefficient (assumed to be 1)

Also from Reference 3:

$$A_p = \frac{\text{total projected propeller area}}{1.067 - 0.229\ p/d} \qquad \text{(A-5)}$$

where p/d = propeller pitch to diameter ratio (assumed to be 1)

The angle function for the form, friction, and propeller drag were taken from apparent trends in experimental data from experiments conducted at the Stevens Institute of Technology, Hoboken, N.J. (Ref 8).

To limit the amount of detailed input to the program, an attempt was made to express the total projected propeller area for various vessels in terms of known quantities. Figure A-2 shows the area ratio (length x beam/total projected propeller area) versus length x beam for the program's five major vessel groups. Each data point represents a class of ship. The area ratio value given to represent each group of data points considers the number of ships in each class. Cruisers, cargo, and tankers are represented by a single area ratio. Destroyers and carriers each are represented by two distinct groups as a function of L x B. The total projected propeller area can be given in terms of the area ratio as follows:

$$\text{Total projected propeller area} = \frac{L \times B}{\text{area ratio}} \qquad \text{(A-6)}$$

The simplicity in this method of determining propeller drag is justified at this time because of the overall uncertainty in the current load equations. Its arrangement in the program lends itself to later refinement.

Lateral Current Loads

The lateral current load on the vessel is due primarily to form drag. The lateral current load is calculated by the following equation (Ref 2):

$$F_{yc} = 1/2\ \rho_c\ V_c^2\ C_{yc}\ A_c\ K \qquad \text{(A-7)}$$

where A_c = side-projected area below the waterline of the vessel = length x draft (ft^2)

C_{yc} = lateral current load coefficient

K = depth to draft factor

The lateral current load coefficient was obtained from one source, based on tanker model tests. It is presented as a Fourier series (Ref 2):

$$C_{yc} = \sum_{n=1}^{5} b_n \sin(n\theta_c) \qquad \text{(A-8)}$$

in which $b_1 = 0.908$ $b_4 = 0$

$b_2 = 0$ $b_5 = -0.033$

$b_3 = -0.116$

The depth to draft factor in Equation A-7 compensates for shallow water effects. The following equation was fitted to the curve in Reference 2:

$$K = 1 + \frac{1}{(WD/T)^2 - 1} \qquad \text{(A-9)}$$

where WD = water depth (ft)

T = vessel draft (ft)

Yaw Moment Due to Currents

The yaw moment on the vessel due to currents is calculated by the following equation (Ref 2):

$$M_c = 1/2\ \rho_c\ V_c^2\ C_{xyc}\ A_c\ L\ K \qquad \text{(A-10)}$$

where C_{xyc} = current yaw moment coefficient

K = depth to draft factor (Equation A-9)

The current yaw moment coefficient was obtained from the same source as the lateral load coefficient. Expanded in Fourier series the coefficient is given as follows:

$$C_{xyc} = \sum_{n=1}^{5} bn \sin n\theta_c \qquad \text{(A-11)}$$

in which $b_1 = -0.0252$ $b_4 = 0.0109$
$b_2 = -0.0904$ $b_5 = 0.0011$
$b_3 = 0.0032$

WAVE DRIFT LOADS ON VESSELS

The wave drift force is a result of the vessel acting as an obstruction to the transport of momentum in the wave field. The method used to determine the steady drift forces (longitudinal, lateral, and yaw moment) assumes the drift force operators on the vessel as a function of the wave frequency is known. These operators (transfer functions) were based primarily on model tests. The transfer functions are plotted versus a nondimensional wavelength. The program converts each function to the angular frequency domain by the following deep water relationship:

$$\omega = \left(\frac{2\pi g}{\lambda}\right)^{1/2} \qquad \text{(A-12)}$$

There is a larger scatter in the available data and the effect of water depth to draft is not considered. Figure A-3 shows lateral drift forces on a tanker for headings of 90 and 45 degrees (Ref 12). From this one model test it appears the lateral drift force varies with the sine squared of the incident angle. In a similar manner the longitudinal drift force is assumed to vary with cosine squared of the incident angle.

Wave Spectra

Two wave spectra are available in the program. Both are of the following form:

$$S(\omega) = A/\omega^5 \, e^{-(B/\omega^4)} \qquad \text{(A-13)}$$

where ω is the wave freqency.

If the user indicates the wave period is known (as in fetch limited anchorages) then the Bretschneider wind wave model is used, where:

$A = 262.5\ H^2/T^4$

$B = 1050/T^4$

H = significant wave height (ft)

T = significant wave period (sec)

If the user indicates the wave period is not known then the Pierson-Moskowitz wind wave model is used, where:

$A = 8.4$

$B = 33.56/H^2$

Longitudinal Wave Drift Loads

Figure A-4 shows representative nondimensional drift force coefficients versus the nondimensional wavelength for longitudinal loads. There is a large scatter in the drift force values. Additional parameters such as the bow angle should possibly be included in the nondimensional plot. The solid curve represents the transfer function used in the program, where as the dotted and dashed curves represent experimental and theoretical values respectively. The longitudinal drift force is obtained with the following equation (Ref 2):

$$F_{xd} = \rho_w g \, L \int_0^\infty S(\omega)\left(\frac{F_{xd}(\omega)}{1/2\ \rho_\omega g\ a^2}\right) d\omega \cos^3 \theta_d \qquad \text{(A-14)}$$

where g = acceleration of gravity (32.2 ft/sec^2)

$F_{xd}(\omega)/(1/2\ \rho_\omega\ g\ a^2)$ = longitudinal drift force operator

θ_d = local angle of the waves

a = wave amplitude

Lateral Wave Drift Loads

Figure A-5 shows representative nondimensional drift force coefficients for lateral loads. The scatter is not as pronounced as it was for longitudinal coefficients. The transfer function in STATMOOR (represented by a solid line) is a five-line sequence representation of the drift forces on a flat plate. The lateral drift force is obtained by the following equation (Ref 2):

$$F_{yd} = \rho_w g \, L \int_0^\infty S(\omega)\left(\frac{F_{yd}(\omega)}{1/2\ \rho_\omega g\ a^2}\right) d\omega \sin^3 \theta_d \qquad \text{(A-15)}$$

where $F_{yd}(\omega)/(1/2\ \rho_\omega\ g\ a^2)$ is the transfer function for lateral drift forces.

NOTE: Figures A-4 and A-5 have different scales than the equations.

Yaw Moment Due to Waves

Figure A-6 shows the nondimensional yaw drift moment for a heading of 45 degrees. Only two theoretical curves (dashed) are shown with the program's (solid) transfer function. The maximum yaw moment due to wave drift forces was assumed to be at 45 degrees and periodic over 180 degrees. The resulting yaw moment equation is given by:

$$M_d = \rho_w g \, L^2 \int_0^{\infty} S(\omega) \left(\frac{M_d(\omega)}{1/2 \; \rho_w g \; L \; a^2} \right) d\omega \; \sin(2\theta_d) \qquad \text{(A-16)}$$

where $M_d(\omega)/(1/2 \; \rho_w g \; L \; a^2)$ is the transfer function for yaw moment due to waves.

WIND LOADS ON VESSELS

All methods for determining vessel wind loads were taken from Reference 1, which summarized results based on experimental wind load measurements for over 40 ships. The methods in the report do not take the simplistic approach for representing the forces on all vessels by three force versus angle curves. The force curves are instead a function of the vessel characteristics. Among some of the items considered are:

- The relative areas and positions of the hull and superstructure in the wind gradient.
- The nature of the superstructure: distinct or distributed.
- The relative longitudinal position of the superstructure.

This last item is illustrated in Figure A-7, where a trend in the wind yaw moment can be observed as the location of the superstructure changes.

Longitudinal Wind Loads

The longitudinal wind load is a strong function of the ship type. Both the longitudinal wind drag coefficient and the normalized shape function (the manner in which the load changes as a function of the angle) are based upon subjective information about the vessel. The longitudinal wind load is given by the equation:

$$F_{xw} = 1/2 \; \rho_A \; V_w^2 \; A_x \; C_{xw} \; f_x(\theta_w) \qquad \text{(A-17)}$$

where
- ρ_A = the density of air (2.4×10^{-3} slug/ft^3)
- V_w = wind velocity at a reference height of 33 ft (ft/sec)
- A_x = longitudinal projected vessel area above the waterline (ft^2)
- C_{xw} = longitudinal wind drag coefficient
- $f_x(\theta_w)$ = normalized longitudinal shape function dependent on incident wind angle (θ_w)

For longitudinal loads the shape function can be one of two forms. For vessels with single distinct superstructures and for hull dominated ships the shape function takes the following form:

$$f_x(\theta_w) = \cos \Phi \qquad \text{(A-18)}$$

Vessels with distributed superstructures have a shape function of the following form:

$$f_x(\theta_w) = \frac{\sin\gamma - (\sin 5\gamma)/10}{1 - 1/10} \qquad \text{(A-19)}$$

In both shape functions the angles Φ and γ are a function of the incident wind angle and the longitudinal location of the superstructure. Equation A-19 gives a flattened out shape function around the head wind conditions.

Lateral Wind Loads

Calculation of the lateral wind load is more straightforward than the longitudinal wind load. As mentioned in the previous section, the wind velocity used in the wind load calculations is for a height of 33 feet (10 meters). The user enters the known wind velocity and corresponding height at which it is measured, and the program determines the calculation wind speed V_w from the wind gradient relationship:

$$V_w = \left(\frac{33}{h_R}\right)^{1/7} V_R \qquad \text{(A-20)}$$

where H_R = reference height at which the wind velocity was measured (ft)

V_R = user-supplied wind velocity at the reference height (knots)

V_w = wind velocity at 33 feet (knots, program converts it to ft/sec for calculations)

The lateral wind drag coefficient is obtained by considering the position of both the hull and the superstructure within the wind gradient. The lateral wind load is given by the equation:

$$F_{yw} = 1/2\ \rho_A V_w^2 A_y C_y f_y(\theta_w) \qquad \text{(A-21)}$$

where A_y = lateral project vessel area above the waterline (ft^2)

C_y = lateral wind drag coefficient, where

$$C_y = \frac{0.92\left[\left(\frac{\bar{V}_s}{V_w}\right)^2 A_s + \left(\frac{\bar{V}_H}{V_w}\right)^2 A_H\right]}{A_y} \qquad \text{(A-22)}$$

where A_s = lateral projected superstructure area (ft^2)

A_H = lateral projected hull area above the waterline (ft^2)

$\bar{V}_s$ = average wind velocity over the superstructure (ft/sec)

$\bar{V}_H$ = average wind velocity over the hull (ft/sec)

$f_y(\theta_w)$ = normalized lateral shape function

Both $(\bar{V}_s/V_w)$ and $(\bar{V}_H/V_w)$ are obtained by integrating the normalized wind gradient curve (similar to Equation A-20). The curve is integrated between the top and bottom height of the assumed rectangular superstructure or hull area.

The following normalized shape function was used for all vessels:

$$f_y(\theta_w) = \frac{\sin \theta_w - \sin(5\theta_w)/20}{1 - 1/20} \tag{A-23}$$

This is similar to the longitudinal shape function, as it flattens out the lateral shape function near beam winds.

Yaw Moment Due to Wind

The yaw moment coefficients and shape function are also strongly dependent on the vessel group and the relative longitudinal location of the superstructure. The wind yaw moment is given by the following equation:

$$M_w = 1/2\ \rho_A V_w^2 A_y L C_M f_M(\theta_w) \tag{A-24}$$

where C_m = wind yaw moment coefficient amplitude

$f_M(\theta_w)$ = normalized yaw moment shape function

Reference 1 did not attempt curve fits for available yaw moment data. However, for the purposes of this program the curves that appeared in that report were fitted with two half sine waves. Therefore the shape function has the following form:

$$f_M(\theta_w) = \sin \Phi \tag{A-25}$$

where Φ is the function of incident wind angle and vessel group.

The variables Φ and C_M change with the vessel group and the relative longitudinal location of the superstructure. The method used for determining wind yaw moment is not as analytical as the wind induced longitudinal and lateral loads. However, it does express the trends found in experimental data.

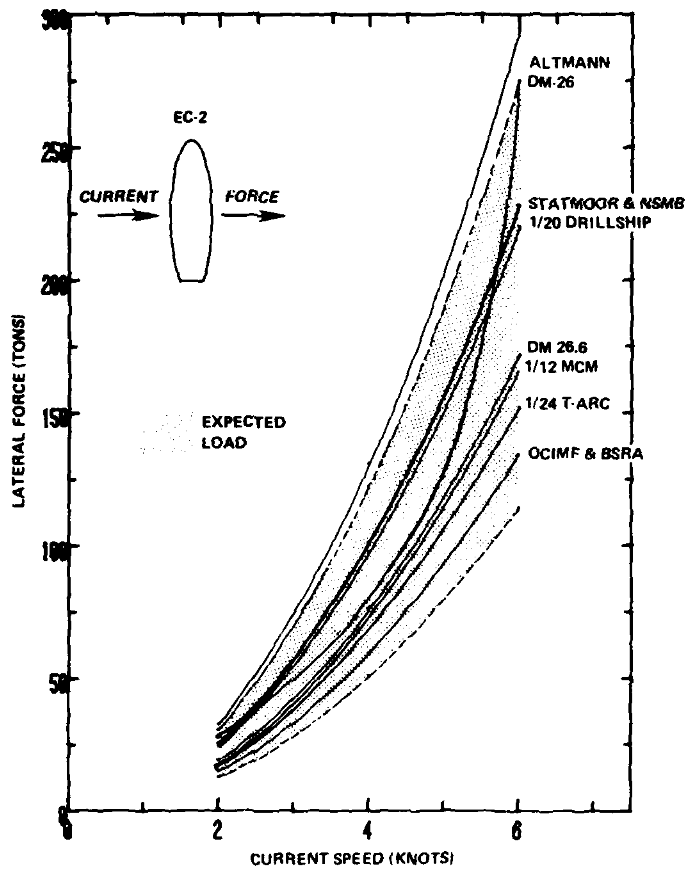

Figure A-1. Comparison of state-of-the-art current load methods.

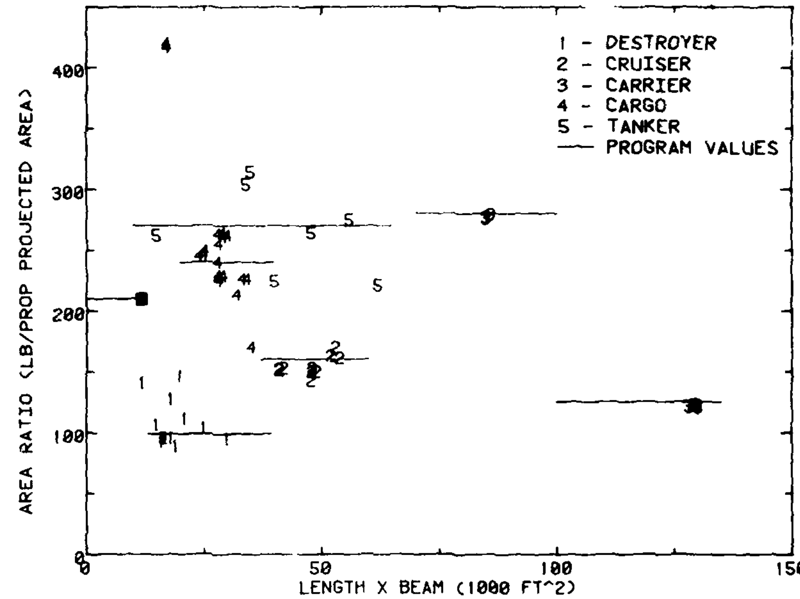

Figure A-2. Propeller area ratios for the major vessel groups.

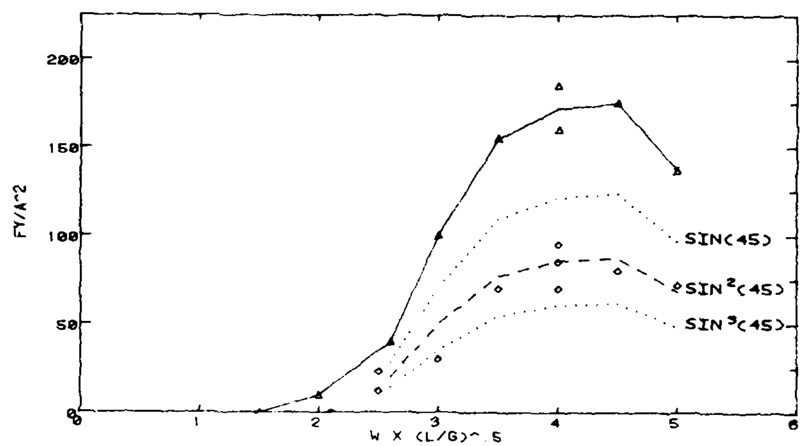

Figure A-3. Lateral drift force angle function.

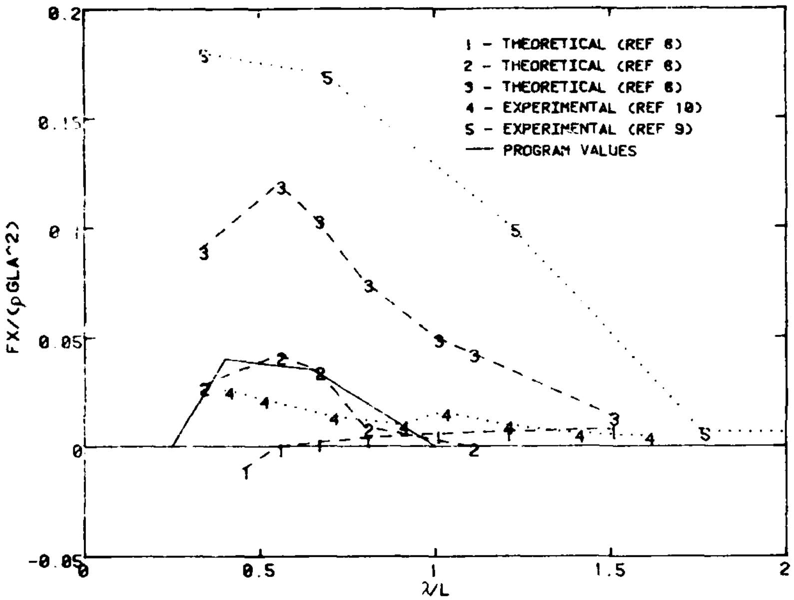

Figure A-4. Longitudinal drift force operators (heading = 0 degree).

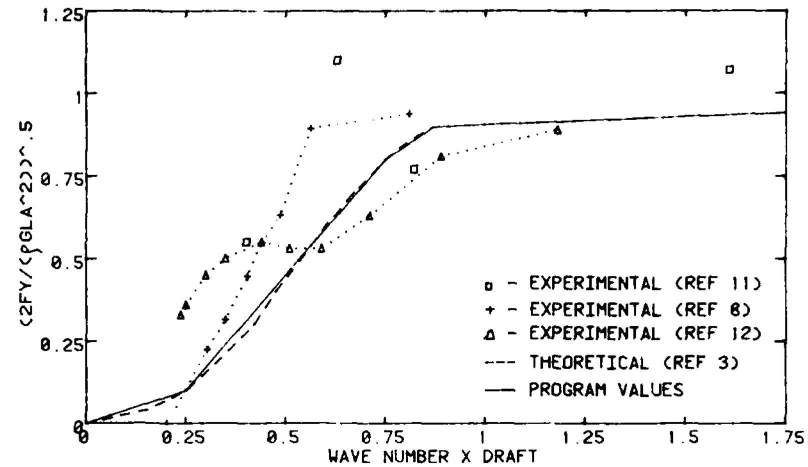

Figure A-5. Lateral drift force operators (heading = 90 degrees).

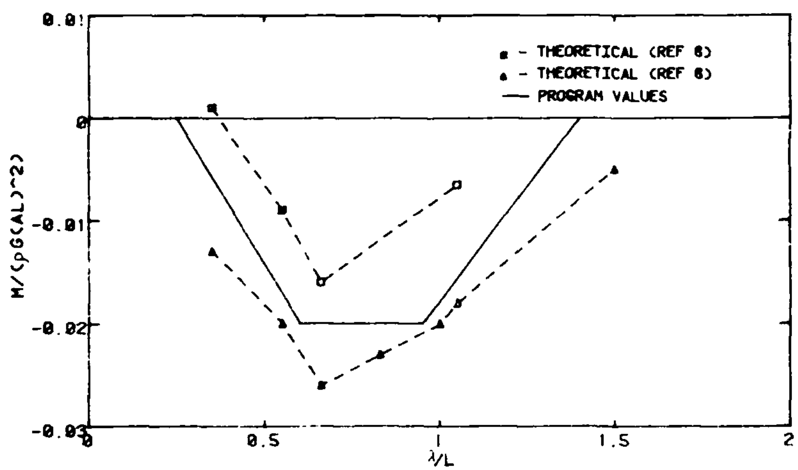

Figure A-6. Wave yaw moment operators (heading = 45 degrees).

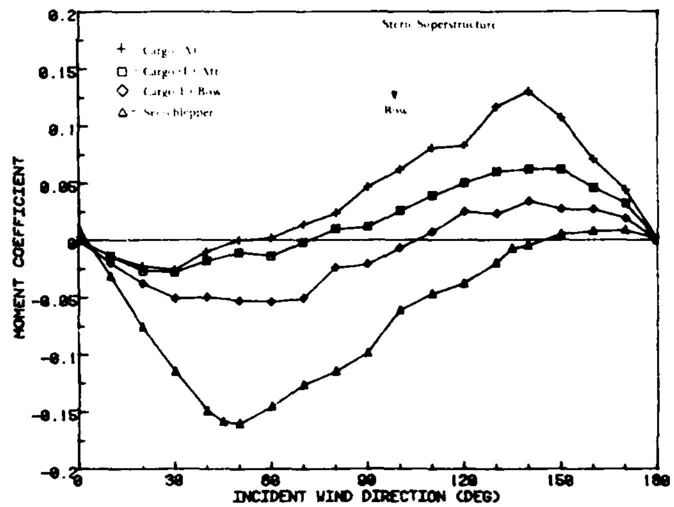

Figure A-7. Wind yaw moment coefficients versus superstructure location.

Appendix B

BLOCK FLOW CHART, SAMPLE OUTPUT, AND LISTINGS

STATMOOR was written in the BASIC language for Digital Equipment Corporation's (DEC) Modular Instrument Computer (MINC). This version of BASIC is typical for most desk top computers. If the program is to be converted for use on another computer, the following notes will be of value:

1. If the OR and AND logical operators can be used in IF statements the program can be made significantly shorter in some sections.

2. The MINC BASIC graphics was written to facilitate data acquisition. The graphics program (MGRAPH) will need to be rewritten for most versions of BASIC. Shapes were defined then rotated with the methods explained in Reference 13.

3. Because of the limited programming work space, approximately 7,000 words, STATMOOR was broken into five programs. Except for slower interaction, the user is not aware of program segmentation. The COMMON and CHAIN statements were used to segment the program. The COMMON statement appears toward the beginning of each program and protects the listed variables when each program is run. The CHAIN statement replaces a program in the work space with the designated program and continues execution at the specified line number. The block flow chart shown in Figure B-1 illustrates the relationship between the programs.

A sample tabular output is shown in Figure B-2, which summarizes the user-supplied information, the various coefficients and final magnitudes of the components of the loads at equilibrium, and the equilibrium conditions.

A listing of the program is presented as Figure B-3.

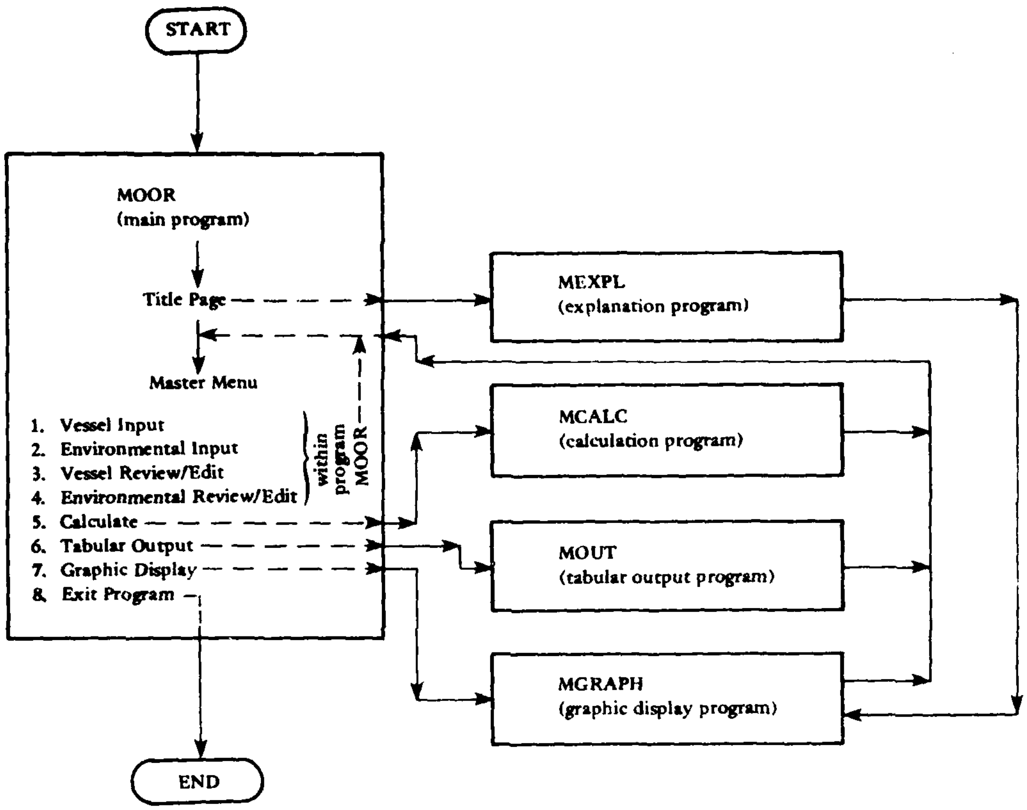

Figure B-1. STATMOOR block flow chart showing program interactions.

Figure B-2. Sample tabular output from STATMOOR.

PROGRAM STATMOOR - STATIC MOORING ANALYSIS
18-NOV-81 10:49:34

70 KDWT TANKER NSMB TEST #7561

USER INPUT

VESSEL INPUT

VESSEL GROUP: TANKER

CI TANKER	FULLY BALLASTED	SUPERSTRUCTURE LOCATION	CLUTTERED DECK
N	Y	STERN	N

DISPLACEMENT	WATERLINE LENGTH	BEAM	DRAFT
87,600 LONG TONS	740.00 FT	112.60 FT	43.90 FT

WIND AREA INPUT (AREAS IN SQUARE FEET)

END	HULL SIDE	SUPERSTRUCTURE SIDE
6,560	12,600	6,420
MAX HEIGHT ABOVE WATER LINE	HULL 17.00 FT	SUPERSTRUCTURE 79.00 FT

ENVIRONMENTAL INPUT

CURRENT	SPEED	INCIDENT ANGLE	WATER DEPTH
	4.00 KNOTS	0.00 DEGREES	200. FT

WAVE	SIGNIFICANT HEIGHT	PERIOD KNOWN	SIGNIFICANT PERIOD	INCIDENT ANGLE
	12.00 FT	Y	7.40 SEC.	90.00 DEGREES

WIND	SPEED	INCIDENT ANGLE
	30.00 KNOTS AT 33.0 FT ABOVE THE WATER	90.00 DEGREES

OUTPUT

COEFFICIENT MAXIMUMS

		CXB	CXS	THETAZ	CY	CMB	CMS	THETAM
WIND		0.700	0.600	100.	0.725	0.025	0.110	75.
CURRENT	FRICTION	0.002	0.002					
	FORM	0.100	0.100	0.	-.329*	0.079*		
	PROP	1.000	1.000					

* - INCLUDES ANGLE FUNCTION. DEPTH/DRAFT FACTOR = 1.051

ENVIRONMENTAL FORCES RELATIVE TO VESSEL AT EQUILIBRIUM

		FX LBS	FY LBS	M FT-LBS	LOCAL ANGLE (DEGREES)
CURRENT	FRICTION	6,240.			
	FORM	14,274.	-505,678.	89,662,400.	
	PROP	14,394.			
	TOTAL	34,907.	-505,678.	89,662,400.	-30.45
WAVES	(MEAN)	4,673.	232,303.	-2,761,260.	59.55
WIND		8,341.	40,270.	-649,242.	59.55

STATIC DESIGN RESULTS

HAWSER LOAD	HAWSER ANGLE	SHIP ANGLE
237,979. LBS	312.1 DEGREES	30.4 DEGREES

Figure B-3. STATMOOR listing. MOOR, main program.

```
10 REM PROGRAM 'STATMOOR' STATIC MOORING ANALYSIS
15 REM BY JAMES V. COX CODE L44 CEL
20 REM   26 AUGUST 1981
21 REM MAIN PROGRAM ##############################################
22 REM
23 REM
24 REM
25 COMMON F(19),T(6),C(11),M(5),U(3),D(3),A(5),V(4),H(3)
30 COMMON W(6,2),P(6,2),B(4,1),D$(7),B$(1)
35 COMMON R1,P1,T1,D1,L1,S1,H1,B1,H0,E0,E1,E2,M0,M1,T0
90 GO TO 9300
1600 CHAIN 'MCALC.BAC'
5000 REM VESSEL CHARACTERISTICS INPUT STMT/ROUTINES ##########################
5010 PRINT 'WHICH OF THE FOLLOWING VESSEL GROUPS DOES THE VESSEL FIT IN ?'
5020 PRINT ,'1. CARRIER'
5030 PRINT ,'2. CRUISER'
5040 PRINT ,'3. DESTROYER'
5050 PRINT ,'4. CARGO'
5060 PRINT ,'5. TANKER'
5070 PRINT
5080 GOSUB 5170 \ REM GETS CHOICE
5083 IF D(0)<1 GO TO 5080
5086 IF D(0)>5 GO TO 5080
5090 D(1)=D(0) \ D$(1)='N' \ REM NO C1
5100 ON D(1) GOSUB 5120,5130,5140,5150,5160
5110 RETURN
5120 D$(0)='CARRIER' \ D$(3)='S' \ D$(5)='N' \ RETURN
5130 D$(0)='CRUISER' \ D$(3)='D' \ D$(5)='N' \ RETURN
5140 D$(0)='DESTROYER' \ D$(3)='D' \ D$(5)='N' \ RETURN
5150 D$(0)='CARGO' \ D(2)=3 \ D$(4)='N/A' \ RETURN
5160 D$(0)='TANKER' \ D$(3)='S' \ RETURN
5170 PRINT  \ PRINT  \ PRINT 'ENTER NUMBER OF ABOVE CHOICE'; \ INPUT D(0) \ RETURN
5180 ERASE_TEXT('TEXT') \ MOVE_CURSOR(1,1) \ RETURN
5185 PRINT 'DESCRIBE THE VESSEL (LIMIT TO 15 CHARACTERS): '; \ INPUT B$(0) \ RETURN
5190 PRINT 'IS THE VESSEL A CENTER ISLAND TANKER (Y/N)'; \ INPUT D$(1) \ RETURN
5200 PRINT 'IS THE TANKER FULLY BALLASTED (Y/N)'; \ INPUT D$(2) \ RETURN
5210 PRINT 'DOES THE VESSEL HAVE A DISTRIBUTED OR SINGLE SUPERSTRUCTURE (D/S)'; \ INPUT D$(3) \ RETURN
5220 PRINT 'WHICH OF THE FOLLOWING BEST DESCRIBES THE LOCATION OF THE VESSEL'S            SUPERSTRUCTUR
E ?'
5230 PRINT ,'1. STERN'
5240 PRINT ,'2. SUPERSTUCTURE JUST AFT OF MIDSHIP'
5250 PRINT ,'3. CENTERED SUPERSTRUCTURE'
5260 PRINT ,'4. SUPERSTRUCTURE FORWARD OF MIDSHIP'
5265 PRINT ,'5. BOW'
5270 PRINT
5280 GOSUB 5170
5283 IF D(0)<1 THEN  GO TO 5280
5286 IF D(0)>5 THEN  GO TO 5280
5290 D(2)=D(0)
5300 ON D(2) GOSUB 5310,5320,5330,5340,5345
5305 RETURN
5310 D$(4)='STERN' \ RETURN
5320 D$(4)='SUPERSTRUCTURE JUST AFT OF MIDSHIP' \ RETURN
5330 D$(4)='CENTERED SUPERSTRUCTURE' \ RETURN
5340 D$(4)='SUPERSTRUCTURE FORWARD OF MIDSHIP' \ RETURN
5345 D$(4)='BOW' \ RETURN
5350 PRINT 'DOES THE VESSEL HAVE CLUTTERED DECKS (I.E. MASTS, BOOMS, PIPES, AND  OTHER      SUBSTANTIAL O
BSTRUCTIONS) (Y/N)';
5351 INPUT D$(5) \ RETURN
5360 PRINT 'WHAT IS THE DISPLACEMENT OF THE 'D$(0)' IN LONG TONS'; \ INPUT D1 \ RETURN
5370 PRINT 'WHAT IS THE WATERLINE LENGTH IN FEET'; \ INPUT L1 \ RETURN
5380 PRINT 'WHAT IS THE BEAM IN FEET'; \ INPUT B1 \ RETURN
5390 PRINT 'WHAT IS THE DRAFT IN FEET'; \ INPUT T1 \ RETURN
```

```
5400 PRINT 'WHAT IS THE END PROJECTED AREA OF THE VESSEL ABOVE THE WATERLINE IN SQUARE      FEET (AS SEEN
 BY A HEAD WIND)';
5401 INPUT A(5) \ RETURN
54'  PRINT 'WHAT IS THE SIDE PROJECTED AREA OF THE HULL ABOVE THE WATERLINE IN SQUARE FEET  (AS SEEN BY A
 BEAM WIND)'; \ INPUT A(2)
5411 RETURN
5430 PRINT 'WHAT IS THE AVERAGE HEIGHT OF THE TOP OF THE HULL ABOVE THE WATERLINE IN       FEET'; \ INPU
T H(2) \ RETURN
5440 PRINT 'WHAT IS THE SIDE PROJECTED AREA OF THE SUPERSTRUCTURE ABOVE THE WATERLINE IN    SQUARE FEET (
AS SEEN BY A BEAM WIND)';
5441 INPUT A(3) \ RETURN
5450 PRINT 'WHAT IS THE AVERAGE HEIGHT OF THE TOP OF THE SUPERSTRUCTURE ABOVE THE WATERLINE IN FEET'; \ I
NPUT H(3) \ RETURN
5500 REM ENVIRONMENTAL CONDITIONS INPUT STMT/ROUTINES **************************
5505 PRINT 'DESCRIBE THE MOORING (LIMIT TO 15 CHARACTERS): '; / INPUT B$(1) / RETURN
5510 PRINT ,'SPEED IN KNOTS = '; \ INPUT V(N) \ RETURN \ REM CURRENT OR WIND
5515 PRINT ,'WATER DEPTH IN FEET = '; \ INPUT H1 \ RETURN
5520 PRINT ,'DIRECTION IN DEGREES = '; \ INPUT U(N) \ RETURN \ REM ALL LOADS.
5530 PRINT ,'SIGNIFICANT WAVE HEIGHT IN FEET = '; \ INPUT HO \ RETURN
5540 PRINT ,'DO YOU KNOW THE SIGNIFICANT WAVE PERIOD (Y/N)'; \ INPUT D$(6) \ RETURN
5550 PRINT ,'SIGNIFICANT WAVE PERIOD IN SECONDS = '; \ INPUT TO \ RETURN
5560 PRINT ,'HEIGHT OF VELOCITY MEASUREMENT IN FEET (E.G. 33 FT) = '; \ INPUT H(1) \ RETURN
5600 REM VESSEL CHARACTERISTICS INPUT CONTROL ROUTINE ***********************
5605 GOSUB 5180
5607 PRINT ,'VESSEL CHARACTERISTICS INPUT'
5608 PRINT L$ \ PRINT
5609 GOSUB 5185 \ PRINT
5610 GOSUB 5010 \ REM VESSEL GROUP
5615 PRINT
5620 ON D(1) GOSUB 5660,5660,5660,5700,5740
5630 FOR N=1 TO 9
5635 PRINT
5640 ON N GOSUB 5360,5370,5380,5390,5400,5410,5430,5440,5450
5650 NEXT N \ GO TO 9000
5660 REM WARSHIP - NO ADDITIONAL OBJECTIVE INPUT ***************************
5670 RETURN
5700 REM CARGO ***********************************
5710 GOSUB 5210
5717 PRINT
5720 IF D$(3)='S' THEN  GOSUB 5220
5725 PRINT
5730 GOSUB 5350 \ RETURN
5740 REM TANKER ***********************************
5750 GOSUB 5190 \ PRINT  \ GOSUB 5200
5755 D$(4)='N/A'
5757 PRINT
5760 IF D$(1)='N' THEN  GOSUB 5220
5765 PRINT
5770 GOSUB 5350 \ RETURN
5800 REM ENVIRONMENTAL CONDITIONS, INPUT CONTROL ROUTINE ********************
5810 GOSUB 5180
5820 PRINT ,'ENVIRONMENTAL CONDITIONS INPUT'
5830 PRINT L$ \ PRINT  \ PRINT
5835 GOSUB 5505 \ PRINT
5840 PRINT 'CURRENTS'
5850 PRINT '________'
5860 N=0 \ GOSUB 5510
5865 GOSUB 5515
5870 N=1 \ GOSUB 5520
5880 PRINT
5890 PRINT 'WAVES'
5900 PRINT '_____'
```

```
5910 GOSUB 5530 \ GOSUB 5540
5920 T0=0
5930 IF D$(6)='Y' THEN  GOSUB 5550
5940 N=2 \ GOSUB 5520
5950 PRINT
5960 PRINT 'WIND'
5970 PRINT '____'
5980 GOSUB 5560
5990 N=1 \ GOSUB 5510
6000 N=3 \ GOSUB 5520
6010 GO TO 9000
6100 REM VESSEL CHAR REVIEW STMT/ROUTINES *********************************
6105 PRINT N$'. VESSEL DESCRIPTION: 'B$(0) \ RETURN
6110 PRINT N$'. VESSEL GROUP: 'D$(0) \ RETURN
6120 PRINT N$'. CENTER ISLAND TANKER: 'D$(1) \ RETURN
6125 PRINT N$'. FULLY BALLASTED: 'D$(2) \ RETURN
6130 PRINT N$'. SUPERSTRUCTURE TYPE: 'D$(3) \ RETURN
6140 PRINT N$'. SUPERSTRUCTURE LOCATION: 'D$(4) \ RETURN
6150 PRINT N$'. CLUTTERED DECKS: 'D$(5) \ RETURN
6160 PRINT N$'. DISPLACEMENT = 'D1' LONG TONS.' \ RETURN
6170 PRINT N$'. WATERLINE LENGTH = 'L1' FT.' \ RETURN
6180 PRINT N$'. BEAM = 'B1' FT.' \ RETURN
6190 PRINT N$'. DRAFT = 'T1' FT.' \ RETURN
6200 PRINT N$'. END WIND AREA = 'A(5)' SQUARE FEET.' \ RETURN
6210 PRINT N$'. HULL SIDE WIND AREA = 'A(2)' SQUARE FEET.' \ RETURN
6220 PRINT N$'. TOP OF HULL HEIGHT ABOVE WATERLINE = 'H(2)' FEET.' \ RETURN
6230 PRINT N$'. SUPERSTRUCTURE SIDE WIND AREA = 'A(3)' SQUARE FEET.' \ RETURN
6240 PRINT N$'. TOP OF SUPERSTRUCTURE HEIGHT ABOVE WATERLINE = 'H(3)' FEET.' \ RETURN
6300 REM ENVIRONMENTAL CONDITION REVIEW STMT/ROUTINES *******
6310 PRINT '0. RETURN TO MASTER MENU.' \ RETURN
6315 PRINT N$'. MOORING DESCRIPTION: 'B$(1) \ RETURN
6320 PRINT N$'. CURRENT SPEED = 'V(0)' KNOTS.' \ RETURN
6325 PRINT N$'. WATER DEPTH = 'H1' FEET.' \ RETURN
6330 PRINT N$'. CURRENT DIRECTION = 'U(1)' DEGREES.' \ RETURN
6340 PRINT N$'. SIGNIFICANT WAVE HEIGHT = 'H0' FEET.' \ RETURN
6350 PRINT N$'. SIGNIFICANT WAVE PERIOD KNOWN: 'D$(6) \ RETURN
6360 PRINT N$'. SIGNIFICANT WAVE PERIOD = 'T0' SECONDS.' \ RETURN
6370 PRINT N$'. WAVE DIRECTION = 'U(2)' DEGREES.' \ RETURN
6380 PRINT N$'. WIND VELOCITY MEASURED AT 'H(1)' FEET OFF OF WATER.' \ RETURN
6390 PRINT N$'. WIND SPEED = 'V(1)' KNOTS.' \ RETURN
6400 PRINT N$'. WIND DIRECTION = 'U(3)' DEGREES.' \ RETURN
6480 B=11 \ RETURN
6485 B=14 \ RETURN
6490 B=15 \ RETURN
6500 REM VESSEL CHAR REV/EDIT CONTROL ROUTINE
6510 GOSUB 5180
6520 PRINT ,'VESSEL CHARACTERISTICS REVIEW/EDIT'
6530 PRINT L$ \ PRINT B$(0)'     'B$(1) \ PRINT L$ \ PRINT
6540 GOSUB 6310
6550 ON D(1) GOSUB 6480,6480,6480,6485,6490
6560 FOR N=1 TO B
6570 N$=STR$(N)
6580 ON D(1) GOSUB 6700,6700,6700,6730,6760
6590 NEXT N
6600 GOSUB 5170 \ REM ASK FOR CHOICE
6610 IF D(0)<=0 THEN  GO TO 9000
6620 IF D(0)>B THEN  GO TO 6600
6630 ON D(1) GOSUB 6790,6790,6790,6820,6850
6640 GO TO 6500
6700 REM WARSHIP REVIEW ********************************
6710 ON N GOSUB 6105,6110,6160,6170,6180,6190,6200,6210,6220,6230,6240
```

```
6720 RETURN
6730 REM CARGO REVIEW   **********************************
6740 ON N GOSUB 6105,6110,6130,6140,6150,6160,6170,6180,6190,6200,6210,6220,6230,6240
6750 RETURN
6760 REM TANKER REVIEW  **********************************
6770 ON N GOSUB 6105,6110,6120,6125,6140,6150,6160,6170,6180,6190,6200,6210,6220,6230,6240
6780 RETURN
6790 REM WARSHIP EDIT ************************************
6800 ON D(0) GOSUB 5185,5010,5360,5370,5380,5390,5400,5410,5430,5440,5450
6810 RETURN
6820 REM CARGO EDIT   ************************************
6830 ON D(0) GOSUB 5185,5010,5210,5220,5350,5360,5370,5380,5390,5400,5410,5430,5440,5450
6840 RETURN
6850 REM TANKER EDIT  ***********************************
6860 ON D(0) GOSUB 5185,5010,5190,5200,5220,5350,5360,5370,5380,5390,5400,5410,5430,5440,5450
6870 RETURN
6900 REM ENVIRONMENTAL CONDITION REVIEW/EDIT CONTROL ROUTINE ******************
6910 GOSUB 5180
6920 PRINT ,'ENVIRONMENTAL CONDITION REVIEW/EDIT'
6930 PRINT L$ \ PRINT B$(0)'     'B$(1) \ PRINT L$ \ PRINT
6940 GOSUB 6310
6950 FOR N=1 TO 11
6960 N$=STR$(N)
6970 ON N GOSUB 6315,6320,6325,6330,6340,6350,6360,6370,6380,6390,6400
6980 NEXT N
6990 GOSUB 5170 \ REM ASK FOR CHOICE
7000 IF D(0)<=0 THEN  GO TO 9000
7010 IF D(0)>11 THEN  GO TO 6990
7020 ON D(0) GOSUB 5505,7040,5515,7050,5530,5540,5550,7060,5560,7080,7090
7030 GO TO 6900
7040 N=0 \ GOSUB 5510 \ RETURN
7050 N=1 \ GOSUB 5520 \ RETURN
7060 N=2 \ GOSUB 5520 \ RETURN
7080 N=1 \ GOSUB 5510 \ RETURN
7090 N=3 \ GOSUB 5520 \ RETURN
7230 PRINT  \ PRINT  \ PRINT  \ PRINT ,,'PRESS RETURN TO CONTINUE.'; \ INPUT D$(7) \ RETURN
8200 CHAIN 'MOUT.BAC'
9000 REM ********  MASTER MENU  *********
9010 REM ********************************
9015 L$='______________________________________________________________________________'
9020 GOSUB 5180
9030 PRINT ,,'MASTER MENU'
9040 PRINT L$ \ PRINT  \ PRINT
9050 PRINT ,'1. INPUT VESSEL CHARACTERISTICS.'
9060 PRINT
9070 PRINT ,'2. INPUT ENVIRONMENTAL CONDITIONS.'
9080 PRINT
9090 PRINT ,'3. REVIEW/EDIT VESSEL CHARACTERISTICS.'
9100 PRINT
9110 PRINT ,'4. REVIEW/EDIT ENVIRONMENTAL CONDITIONS.'
9120 PRINT
9130 PRINT ,'5. CALCULATE.'
9140 PRINT
9150 PRINT ,'6. TABULAR OUTPUT.'
9160 PRINT
9170 PRINT ,'7. GRAPHIC DISPLAY.'
9180 PRINT
9183 PRINT ,'8. EXIT PROGRAM.'
9186 PRINT
9190 GOSUB 5170
9200 IF D(0)<0 GO TO 9000
```

```
9210 IF D(0)>8 GO TO 9000
9220 ON D(0) GO TO 5600,5800,6500,6900,1600,8200,10500,9230
9230 GOSUB 5180
9240 PRINT 'BYE BYE'
9250 STOP
9300 REM TITLE SCREEN ********************
9305 A$='CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC'
9310 GOSUB 5180
9320 MOVE_CURSOR(3,1) \ GOSUB 9495 \ GOSUB 9490
9335 PRINT USING A$,'*  STATMOOR  *'
9340 GOSUB 9490 \ GOSUB 9495 \ PRINT
9355 PRINT USING A$,'STATIC MOORING ANALYSIS'
9360 PRINT USING A$,'VERSION 1.0'
9365 PRINT USING A$,'APRIL 1982'
9370 MOVE_CURSOR(15,1)
9375 PRINT USING A$,'BY JAMES V. COX'
9385 PRINT USING A$,'CODE L44'
9387 PRINT USING A$,'NAVY CIVIL ENGINEERING LAB'
9390 PRINT USING A$,'PORT HUENEME, CALIFORNIA 93043'
9415 FOR N=1 TO 3000 \ NEXT N
9420 GO TO 9500
9490 PRINT USING A$,'*            *' \ RETURN
9495 PRINT USING A$,'**************' \ RETURN
9500 REM EXPLANATION/ASSUMPTION PAGE ********
9510 GOSUB 5180
9520 PRINT 'DO YOU WISH TO REVIEW THE PROGRAM EXPLANATION (Y/N)'; \ INPUT D$(7)
9530 IF D$(7)<>'N' THEN CHAIN 'MEXPL.BAC'
9550 GO TO 9000
10500 CHAIN 'MGRAPH.BAC'
32000 END
```

```
10 REM PROGRAM 'STATMOOR' STATIC MOORING ANALYSIS
15 REM BY JAMES V. COX CODE L44 CEL
20 REM   26 AUGUST 1981
21 REM EXPLANATION PROGRAM **********************************************
22 REM
23 REM
24 REM
25 COMMON F(19),T(6),C(11),M(5),U(3),D(3),A(5),V(4),H(3)
30 COMMON W(6,2),P(6,2),B(4,1),D$(7),B$(1)
35 COMMON R1,P1,T1,D1,L1,S1,H1,B1,H0,E0,E1,E2,M0,M1,T0
50 GOSUB 5180
60 PRINT '          PROGRAM STATMOOR - STATIC MOORING ANALYSIS'
70 PRINT  \ PRINT 'OVERVIEW' \ PRINT '--------'
80 PRINT 'THIS PROGRAM CALCULATES THE EQUILIBRIUM CONDITION OF A SINGLE POINT MOORED'
90 PRINT 'SHIP ACTED UPON BY STEADY CURRENT, WAVE, AND WIND LOADS.  THE LOADING CURVES'
100 PRINT 'WERE OBTAINED FROM A VARIETY OF SOURCES, AND NO DYNAMICS WERE INCLUDED.'
110 PRINT 'FOR FURTHER INFORMATION SEE REPORT TM44-82-1.'
120 PRINT  \ PRINT 'PROGRAM OPERATION' \ PRINT '-----------------'
130 PRINT 'THE PROGRAM IS WRITTEN IN A CONVERSATIONAL MODE.  YOU MUST RESPOND TO'
140 PRINT 'QUESTIONS AND CHOICES.  INPUT CONSIST OF TYPED DESCRIPTIONS, NUMERICAL'
150 PRINT 'VALUES, AND LETTERS.'
160 PRINT '*  TYPED DESCRIPTIONS - AT ONE POINT IN THE PROGRAM YOU WILL BE ASKED TO'
170 PRINT 'DESCRIBE THE SHIP.  FOR EXAMPLE YOU MAY TYPE  70 KDWT TANKER  FOLLOWED'
180 PRINT 'BY THE RETURN KEY.'
190 PRINT '*  NUMERICAL VALUES - THEY MUST BE TYPED IN WITH NO ALPHA CHARACTERS AND'
200 PRINT 'FOLLOWED BY THE RETURN KEY.'
210 PRINT '*  LETTERS - AT SEVERAL POINTS THE PROGRAM ASK A QUESTION CONTAINING THE'
220 PRINT 'CHARACTERS (Y/N).  THIS MEANS YOU SHOULD ENTER  Y  FOR YES OR  N  FOR  NO,'
230 PRINT 'FOLLOWED BY THE RETURN KEY.'
240 PRINT  \ GOSUB 7230
250 GOSUB 5180
260 PRINT 'PROGRAM OPTIONS' \ PRINT '---------------'
270 PRINT '*  INPUT SECTIONS - YOU CAN ENTER ALL THE INFORMATION ABOUT THE VESSEL'
280 PRINT 'OR THE ENVIRONMENTAL LOADS.'
290 PRINT '*  REVIEW/EDIT SECTIONS - YOU CAN REVIEW AND EDIT INDIVIDUAL VALUES OF THE'
300 PRINT 'INPUT FOR THE VESSEL OR THE ENVIRONMENAL LOADS.'
310 PRINT '*  CALCULATION SECTION - CALCULATES EQUILIBRIUM CONDITION (WITH AN OPTION TO'
315 PRINT 'FIND THE WORST CURRENT ANGLE) AND HAS A BRIEF VIDEO OR PRINTER OUTPUT.'
320 PRINT '*  TABULAR OUTPUT SECTION - YOU CAN OBTAIN VIDEO OR PRINTER OUTPUT.'
330 PRINT '*  GRAPHIC OUTPUT SECTION - PLOTS EQULIBRIUM CONDITION OF SHIP AND HAWSER'
340 PRINT 'WITH INCIDENT ANGLES OF ENVIRONMENTAL LOADS.'
350 PRINT '*  EXPLANATION - YOU CAN USE THE GRAPHICS DEMO TO CREATE GRAPHIC OUTPUT'
360 PRINT 'INDEPENDENT OF THE CALCULATED RESULTS.'
370 PRINT  \ PRINT 'ANGLE CONVENTION' \ PRINT '----------------'
380 PRINT 'THERE ARE TWO ANGLE CONVENTIONS IN THE PROGRAM, ABSOLUTE AND LOCAL '
390 PRINT '*  ABSOLUTE - THIS ANGLE IS ZERO AT TWELVE O'CLOCK ON THE VIDEO AND INCREASES'
400 PRINT 'COUNTERCLOCKWISE.  IT IS USED TO ENTER THE ENVIRONMENTAL LOAD DIRECTIONS'
410 PRINT 'AND OUTPUT THE SHIP AND HAWSER ANGLES.'
420 PRINT '*  LOCAL - THIS ANGLE IS RELATIVE TO THE VESSEL DIRECTION.  HEAD LOADING'
430 PRINT 'IS ZERO DEGREES AND THE ANGLE INCREASES COUNTERCLOCKWISE.  IT IS USED FOR'
440 PRINT 'CALCULATION OF LOADS AND OUTPUT IN THE FORCE TABLE.'
450 GOSUB 7230
460 GOSUB 5180
470 PRINT 'LOCAL COORDINATE SYSTEM' \ PRINT '-----------------'
480 PRINT 'ALL ENVIRONMENTAL LOADS IN THE OUTPUT TABLE ARE IN THE LOCAL COORDINATE SYSTEM.'
490 PRINT '*  X - POSITIVE AT THE LOCAL ANGLE OF 180 DEGREES, TOWARD THE STERN.'
500 PRINT '*  Y - POSITIVE AT THE LOCAL ANGLE OF 270 DEGREES, TOWARD THE STARBOARD.'
510 PRINT '*  M - POSITIVE COUNTERCLOCKWISE.'
520 PRINT
530 PRINT 'GRAPHICS DEMO' \ PRINT '-------------'
540 PRINT 'THE FOLLOWING DEMONSTRATION IS TO FAMILIARIZE THE USER WITH THE ABSOLUTE'
```

```
550 PRINT 'ANGLE CONVENTION.  THE ANGLE ENTERED FOR THE ENVIRONMENTAL LOADS IS THE'
560 PRINT 'INCIDENT ANGLE.  THESE LOADS ARE REPRESENTED AS FOLLOWS:'
565 PRINT 'C = CURRENT' \ PRINT 'D = WAVE DRIFT FORCE' \ PRINT 'W = WIND' \ PRINT
566 PRINT  \ PRINT 'THE FIRST EXAMPLE IS FOR ALL ANGLES AT ZERO DEGREES.'
567 PRINT 'ADDITIONAL EXAMPLES WITH USER DEFINED ANGLES FOLLOW.' \ PRINT
570 GOSUB 7230
575 DISPLAY_CLEAR
580 B$(0)='GRAPHICS' \ B$(1)='DEMO' \ D$(7)='DEMO'
585 H0=1 \ V(0)=1 \ V(1)=1
650 CHAIN 'MGRAPH.BAC'
5180 ERASE_TEXT('TEXT') \ MOVE_CURSOR(1,1) \ RETURN
7230 PRINT ,'PRESS RETURN TO CONTINUE'; \ INPUT D$(7) \ RETURN
32000 END
```

MCALC, calculation program.

```
10 REM PROGRAM 'STATMOOR' STATIC MOORING ANALYSIS
15 REM BY JAMES V. COX CODE L44 CEL
20 REM   26 AUGUST 1981
21 REM CALCULATION PROGRAM ****************
22 REM
23 REM
24 REM
25 COMMON F(19),T(6),C(11),M(5),U(3),D(3),A(5),V(4),H(3)
30 COMMON W(6,2),P(6,2),B(4,1),D$(7),B$(1)
35 COMMON R1,P1,T1,D1,L1,S1,H1,B1,H0,E0,E1,E2,M0,M1,T0
40 DEF FND(X)=X*180/PI \ REM CONVERSION FROM RAD TO DEG.
43 DEF FNR(X)=X*PI/180 \ REM CONVERSION FROM DEG TO RAD
45 REM FOURIER COEF. DATA*****************
50 DATA .908,0,-.116,0,-.033
53 DATA -.0252,-.0904,.0032,.0109,.0011
55 REM DRIFT FORCE TRANSFORM DATA
57 REM FX LAMDA/L  TRANS
60 DATA 1,.65,.4,.25
63 DATA 0,0,.07,.08,0
65 REM FY    KT     TRANS
67 DATA .25,.75,.87,3
70 DATA 0,.01,.64,.81,1
73 REM M LAMDA/L    TRANS
75 DATA 1.4,.95,.6,.25
77 DATA 0,0,-.02,-.02,0
78 03=0 \ GOSUB 5180 \ PRINT 'DO YOU WISH TO FIND THE CURRENT DIRECTION (WITHIN 10 DEGREES) WHICH PRODUCES'
79 PRINT 'MAXIMUM HAWSER LOAD (Y/N) '; \ INPUT 01$
80 PRINT 'DO YOU WANT VIDEO OR PRINTED RESULTS (V/P) '; \ INPUT 02$
81 02=0
82 IF 02$='P' THEN 02=1
83 OPEN 'LP:' FOR OUTPUT AS FILE 1
84 GO TO 1600
85 PRINT #02,,,'CALCULATION OUTPUT'
86 L$='_____________________________________________________________________________'
87 PRINT #02,L$ \ PRINT #02,B$(0)'     'B$(1) \ PRINT #02,L$ \ PRINT #02,
88 PRINT #02,'HAWSER LOAD             HAWSER ANGLE            SHIP ANGLE'
89 A$='####,### LBS          ####.# DEGREES          ####.# DEGREES' \ RETURN
95 PRINT #02,USING A$,F(0),T(6),E2 \ RETURN
100 REM FX CURRENT SUBROUTINE**********
110 REM CONSIDER FORM,FRICTION,AND PROPELLER DRAG
120 REM REF.     DM-26 DTC              ALTMAN
125 IF V(0)=0 THEN  GO TO 140
130 A=COS(B) \ R2=ABS(R1*A) \ C(1)=.075/(LOG10(R2)-2)^2
140 F(2)=F(1)*A \ REM PROP
150 F(4)=F(3)*A^3*C(1) \ REM FRIC
160 F(6)=F(5)*A^3*.1 \ REM FORM
170 F(7)=F(2)+F(4)+F(6)
180 RETURN
200 REM FOURIER SERIES COEF CALC'S*****
210 C=0
220 FOR N=0 TO 4 \ A=N+1 \ C=C+B(N,D)*SIN(A*B) \ NEXT N
230 RETURN
250 REM FY CURRENT SUBROUTINE**************
260 D=0 \ GOSUB 200 \ REM DETERMINES CY(B)
270 C(3)=C \ F(8)=F(9)*C(3)
290 RETURN
350 REM M CURRENT SUBROUTINE*******
360 D=1 \ GOSUB 200 \ REM DETERMINES CM(B)
370 C(11)=C \ M(0)=M(1)*C(11)
380 RETURN
400 REM FX DRIFT SUBROUTINE*****
```

```
410 F(11)=F(10)*COS(B)*ABS(COS(B))
420 RETURN
450 REM FY DRIFT SUBROUTINE*****
460 F(13)=F(12)*SIN(B)*ABS(SIN(B))
470 RETURN
500 REM M DRIFT SUBROUTINE************
510 M(3)=M(2)*SIN(2*B)
520 RETURN
650 REM DEFINE THE EXCITATION AT CONSTANT W INTERVALS AND
655 REM INTERPOLATE THE TRANSFER FUNCTION TO GET THE
660 REM RESPONSE
670 REM USE F AS THE INSTANTANEOUS FREQUENCY VALUE.
680 U=10
690 IF H0>25 THEN U=14
700 F=PI/U
710 B=0
720 K=2
730 D=PI/60
740 FOR I=1 TO 60
759 Z=Q1/F^4
760 IF Z>25 THEN E=1.00000E-06
770 IF Z>25 GO TO 790
780 E=A1/F^5*EXP(-Z)
790 IF F<=W(K,N) GO TO 820
800 K=K+1
810 GO TO 790
820 A=P(K-1,N)+(F-W(K-1,N))/(W(K,N)-W(K-1,N))*(P(K,N)-P(K-1,N))
830 R=E*A
840 B=B+R*D
850 IF F<2.6 GO TO 890
860 IF D=PI/60 THEN F=F+D/2-D*2
870 REM MAKE NEW FREQUENCY INTERVAL = 4*OLD INTERVAL
880 IF D=PI/60 THEN D=D*4
890 F=F+D
900 NEXT I
910 RETURN
950 REM FX WIND SUBROUTINE ******
960 REM DETERMINE SHAPE FUNCTION
970 IF D(3)=0 THEN  GO TO 1050
980 REM DEFAULT DISTRIBUTED SS
990 IF ABS(K)<=T(4) THEN Z=ABS(K)*90/T(4)+90
1000 IF ABS(K)>T(4) THEN Z=ABS(K)*(90/(180-T(4)))+180-90*T(4)/(180-T(4
1010 REM CONVERT TO RADIANS
1020 Z=FNR(Z)
1030 A=(SIN(Z)-SIN(5*Z)/10)/.9
1040 GO TO 1100
1050 REM SINGLE DISTINCT SS
1060 IF ABS(K)<=T(4) THEN Z=ABS(K)*90/T(4)
1070 IF ABS(K)>T(4) THEN Z=(ABS(K)-T(4))*90/(180-T(4))+90
1080 Z=FNR(Z)
1090 A=COS(Z)
1100 REM DETERMINE COEF. CXB OR CXS
1110 IF ABS(K)<=T(4) THEN C(7)=C(4)
1120 IF ABS(K)>T(4) THEN C(7)=C(5)
1130 F(15)=F(14)*A*C(7)
1140 RETURN
1200 REM FY WIND SUBROUTINE**********
1210 Z=FNR(K)
1220 A=(SIN(Z)-SIN(5*Z)/20)/(1-1/20)
1230 F(17)=F(16)*A
1240 RETURN
```

```
1300 REM M WIND SUBROUTINE**********
1310 REM DETERMINE SHAPE FUNCTION
1320 IF ABS(K)<=T(5) THEN  GO TO 1370
1330 REM THETA>THETA Z
1335 Z=K-T(5) \ IF K<0 THEN Z=K+T(5)
1340 Z=Z*180/(180-T(5))
1350 C(10)=C(9)
1360 GO TO 1400
1370 REM THETA<=THETA Z
1380 Z=K*180/T(5)
1390 C(10)=-C(8)
1400 REM CONVERT TO RADIANS
1410 Z=FNR(Z)
1420 M(5)=M(4)*C(10)*SIN(Z)
1430 RETURN
1435 FOR O5=0 TO 350 STEP 10 \ U(1)=O5 \ GO TO 1620
1440 IF U(1)=0 THEN  GOSUB 5180
1441 IF U(1)=0 THEN  GOSUB 85
1442 PRINT #02,"CURRENT ANGLE = "U(1)
1444 GOSUB 95 \ PRINT #02,
1446 IF F(0)<O3 THEN  GO TO 1450
1448 O3=F(0) \ O4=U(1)
1450 NEXT O5
1452 O1$="LAST" \ U(1)=O4 \ GO TO 1620
1460 GOSUB 85 \ GOSUB 95 \ GOSUB 7230 \ D$(7)="N" \ GO TO 1984
1500 REM CALCULATION OF SUM(M)**********
1503 IF E1>360 THEN E1=E1-360
1504 IF E0>=360 THEN E0=E0-360
1505 FOR N=1 TO 3 \ T(N)=U(N)-E1 \ NEXT N
1510 B=FNR(T(1))
1515 GOSUB 250 \ REM FY C
1520 GOSUB 350 \ REM M C
1525 B=FNR(T(2))
1530 GOSUB 450 \ REM FY D
1535 GOSUB 500 \ REM M D
1540 K=T(3)
1545 IF T(3)>180 THEN K=K-360
1547 IF T(3)<-180 THEN K=K+360
1550 GOSUB 1200 \ REM FY W
1555 GOSUB 1300 \ REM M W
1560 REM SUM MOMENTS
1565 M1=M(0)+M(3)+M(5)+L1/2*(F(8)+F(13)+F(17))
1570 RETURN
1580 REM SECTION OF INTERP. LOOP IF SOLUTION IS HIT EXACTLY
1585 Z1=4 \ GO TO 1850
1600 REM CALCULATION SECTION***************
1610 REM PRELOOP SECTION
1615 GOSUB 2000 \ REM CALC INIT SUBROUTINE
1617 IF O1$="Y" THEN  GO TO 1435
1620 I1=30 \ REM ANGLE INCREMENT
1630 E1=0
1640 GOSUB 1500 \ REM ENTER HERE FOR SECOND SOLUTION.
1645 REM LOOP SECTION
1650 E0=E1
1660 M0=M1
1670 E1=E1+I1
1680 GOSUB 1500
1690 D=M0*M1
1700 IF D>0 THEN  GO TO 1650 \ REM CONTINUE INCREMENT
1710 IF D<0 THEN  GO TO 1790 \ REM STABLE OR UNSTABLE SOLUTION
1720 REM D=0
1730 IF M0=0 GO TO 1750
1740 IF M1=0 GO TO 1760
```

```
1750 IF M1<0 THEN  GO TO 1770
1755 GO TO 1650 \ REM UNSTABLE
1760 IF M0>0 THEN  GO TO 1780
1765 GO TO 1650 \ REM UNSTABLE
1770 E2=E0 \ GO TO 1860 \ REM SKIP ZERO PROCESS
1780 E2=E1 \ GO TO 1860 \ REM SKIP ZERO PROCESS
1790 IF M0<M1 GO TO 1650 \ REM UNSTABLE
1800 REM OTHERWISE WE HAVE SOLUTION ENVELOPE
1805 REM CONVERGE ON SOLUTION WITHIN ENVELOPE
1810 REM SET ACCURACY TO BETTER THAN 1 DEGREE, 4 LOOPS
1815 E2=E1 \ M2=M1
1820 FOR Z1=1 TO 4 \ E1=E0+(E2-E0)*M0/(M0-M2)
1830 GOSUB 1500
1835 IF M1=0 THEN  GO TO 1580 \ REM SOLUTION AT E1
1840 IF M1>0 THEN E0=E1
1842 IF M1>0 THEN M0=M1
1845 IF M1<0 THEN E2=E1
1847 IF M1<0 THEN M2=M1
1850 NEXT Z1
1855 E2=E1 \ REM SHIP ANGLE=E2
1860 FOR N=1 TO 3 \ T(N)=U(N)-E2
1861 IF T(N)<0 THEN T(N)=T(N)+360
1862 NEXT N
1865 B=FNR(T(1))
1870 GOSUB 100 \ REM FX C
1875 GOSUB 250 \ REM FY C
1878 GOSUB 350 \ REM M C
1880 B=FNR(T(2))
1885 GOSUB 400 \ REM FX D
1890 GOSUB 450 \ REM FY D
1893 GOSUB 500 \ REM M D
1895 K=T(3)
1900 IF T(3)>180 THEN K=T(3)-360
1905 GOSUB 950 \ REM FX W
1910 GOSUB 1200 \ REM FY W
1913 GOSUB 1300 \ REM M W
1915 F(18)=-(F(7)+F(11)+F(15)) \ REM FX HAWSER
1920 F(19)=-(F(8)+F(13)+F(17)) \ REM FY HAWSER
1923 REM DETERMINE HAWSER ANGLE
1925 IF F(18)=0 THEN  GO TO 1990
1930 T(6)=ATN(F(19)/F(18))
1940 IF F(18)>0 THEN T(6)=T(6)+PI
1950 T(6)=FND(T(6))+E2
1955 IF T(6)>=360 THEN T(6)=T(6)-360
1960 IF T(6)<0 THEN T(6)=T(6)+360
1970 F(0)=SQR(F(18)^2+F(19)^2)
1972 IF O1$='Y' THEN  GO TO 1440
1973 IF O1$='LAST' THEN  GO TO 1460
1974 IF D$(7)='Y' THEN  GO TO 1980
1975 GOSUB 5180
1980 GOSUB 85 \ GOSUB 95
1983 PRINT  \ PRINT  \ PRINT 'DO YOU WISH TO LOOK FOR ANOTHER STABLE SOLUTION (Y/N)'; \ INPUT D$(7)
1984 IF D$(7)<>'Y' THEN CHAIN 'MOOR.BAC' LINE 9000
1985 E1=(INT(E2/30)+1)*30 \ IF E1=360 THEN E1=0
1986 GO TO 1640
1990 IF F(19)>=0 THEN T(6)=1.5*PI
1993 IF F(19)<0 THEN T(6)=.5*PI
1995 GO TO 1960
2000 REM CALCULATION INITIALIZATION
2010 REM SECTION 1... BASED ON SHIP TYPE SETS PROPERTIES  ,
2015 REM              E.G. PROP AREA, MOMENT CURVE ETC.
```

```
2020 REM SET FLAG FOR X - CURRENT SHAPE FUNCTION
2030 D(3)=1
2040 IF D$(3)='S' THEN D(3)=0
2050 REM ASSIGN WIND MOMENT AND FX CURVE VALUES.
2060 K=D(1)
2070 IF K=5 THEN  GOSUB 2480
2080 ON K GOSUB 2300,2340,2370,2400,2425,2435
2090 REM PROPELLER AREA CALCS*************
2100 ON D(1) GOSUB 2240,2250,2260,2270,2280
2110 A(0)=L1*B1/N \ P1=1
2120 A(1)=A(0)/(1.062-.229*P1)
2130 REM SPECTRUM CHOICE
2140 IF D$(6)='Y' THEN  GOSUB 2220
2150 IF D$(6)='N' THEN  GOSUB 2230
2160 GO TO 2500
2220 REM BRETSCHNEIDER WIND WAVE MODEL
2222 IF T0=0 THEN  GO TO 2229
2225 A1=262.5*H0^2/T0^4 \ Q1=1050/T0^4
2228 RETURN
2229 Q1=9.90000E+33 \ RETURN
2230 REM PIERSON MOSKOWITZ WIND WAVE MODEL
2233 IF H0=0 THEN  GO TO 2237
2235 A1=8.4 \ Q1=33.56/H0^2 \ RETURN
2237 A1=8.4 \ Q1=9.90000E+33 \ RETURN
2240 N=125 \ REM CARRIER AREA RATIO (AR)
2243 IF L1*B1<=100000 THEN N=280
2246 RETURN
2250 N=160 \ RETURN \ REM CRUISER AR
2260 N=100 \ REM DESTROYER AR
2263 IF L1*B1<=12000 THEN N=210
2266 RETURN
2270 N=240 \ RETURN \ REM CARGO AR
2280 N=270 \ RETURN \ REM TANKER AR
2290 IF D$(5)='N' THEN RETURN \ REM CLUTTERED DECK ADDER
2295 C(4)=C(4)+.08 \ C(6)=C(6)+.08 \ RETURN
2300 T(4)=120 \ C(4)=.4 \ C(6)=.4 \ REM FX CARRIER
2310 T(5)=90 \ C(8)=.071 \ C(9)=.071 \ REM M
2315 IF D(1)=5 THEN C(4)=.7 \ REM BAL TANKER CHANGES
2317 IF D(1)=5 THEN C(6)=.6
2320 RETURN
2330 T(4)=110 \ C(4)=.7 \ C(6)=.8 \ RETURN \ REM FX
2340 GOSUB 2330 \ REM FX CRUISER
2350 T(5)=90 \ C(8)=.056 \ C(9)=.063 \ REM M
2360 RETURN
2370 GOSUB 2330 \ REM FX DESTROYER
2380 T(5)=110 \ C(8)=.123 \ C(9)=.018 \ REM M
2390 RETURN
2400 F=D(2) \ REM CARGO
2410 IF D$(3)='D' THEN F=3 \ REM DISTRIBUTED - CENTERED
2415 GOSUB 2455
2420 C(4)=.7 \ C(6)=.6 \ GOSUB 2290 \ RETURN
2425 F=D(2) \ GOSUB 2455 \ REM TANKER
2430 C(4)=.7 \ C(6)=.6 \ GOSUB 2290 \ RETURN
2435 T(4)=100 \ C(4)=.8 \ C(6)=.6 \ GOSUB 2290 \ REM F    \ REM CI TANKER
2440 T(5)=90 \ C(8)=.065 \ C(9)=.077 \ REM M
2445 RETURN
2455 ON F GO TO 2460,2465,2470,2475,2477 \ REM COEF AS FUNCTION OF SS LOCATION
2460 T(4)=100 \ T(5)=75 \ C(8)=.025 \ C(9)=.11 \ RETURN \ REM STERN
2465 T(4)=100 \ T(5)=80 \ C(8)=.029 \ C(9)=.096 \ RETURN \ REM SS AFT
2470 T(4)=90 \ T(5)=90 \ C(8)=.04 \ C(9)=.07 \ RETURN \ REM ON MS
2475 T(4)=80 \ T(5)=105 \ C(8)=.054 \ C(9)=.034 \ RETURN \ REM FORWARD MS
```

```
2477 T(4)=75 \ T(5)=110 \ C(8)=.12 \ C(9)=.018 \ RETURN \ REM BOW SS
2480 REM TANKER SUBROUTINE TO SET ASSUMPTION GROUP ***********************
2485 IF D$(1)='Y' THEN K=6
2490 IF D$(2)='N' THEN K=1
2495 RETURN
2500 REM CALCULATION INITILIZATION
2510 REM SECTION 2 PRELIMINARY CALC'S PRIOR TO LOOPS
2520 REM CURRENT ****************
2530 REM FX *********************
2540 C(0)=1 \ V1=1.40000E-05 \ R0=1.9876
2550 A=.5*(1.6835*V(0))^2*R0 \ REM 1/2 RO V^2
2560 F(1)=A*A(1)*C(0) \ REM PROP
2570 S1=1.7*T1*L1+35*D1/T1
2580 F(3)=A*S1 \ REM FRIC
2590 R1=1.6835*V(0)*L1/V1 \ REM REYNOLDS W/O F (THETA)
2600 F(5)=A*T1*B1 \ REM FORM
2610 REM FY ***************
2620 C(2)=1+1/((H1/T1)^2-1)
2630 F(9)=A*L1*T1*C(2)
2640 REM M *************
2650 M(1)=F(9)*L1 \ RESTORE
2660 FOR D=0 TO 1
2670 FOR C=0 TO 4 \ READ B(C,D) \ NEXT C \ NEXT D
2680 REM WAVE DRIFT ***********************************
2690 REM READ IN TRANSFER FUNCTIONS
2700 FOR D=0 TO 2 \ N=5 \ REM 0=FX 1=FY 2=M
2710 FOR C=2 TO N
2720 READ W(C,D) \ NEXT C
2730 FOR C=1 TO N
2740 READ P(C,D) \ NEXT C
2750 W(1,D)=1.00000E-03
2760 REM EXTEND END POINT
2770 W(N+1,D)=12
2780 P(N+1,D)=P(N,D)
2790 NEXT D
2800 REM CONVERT LAMDA/L VALUES TO W
2810 FOR D=0 TO 2 STEP 2
2820 FOR C=2 TO N
2830 W(C,D)=SQR(32.2*2*PI/L1/W(C,D))
2840 NEXT C \ NEXT D
2850 REM CONVERT KT VALUES TO W
2860 FOR C=2 TO N
2970 W(C,1)=SQR(32.2*W(C,1)/T1)
2880 NEXT C
2890 REM NOW ALL TRANS FUNCTIONS ARE IN THE W DOMAIN
2900 REM CALCULATE DRIFT FORCES W/O F(DIRECTION)*******
2910 C=32.2*R0*L1
2920 REM FX DRIFT******************
2930 N=0 \ GOSUB 650 \ REM SPEC X TRANS
2940 F(10)=C*B
2950 REM FY DRIFT **********************
2960 N=1 \ GOSUB 650 \ REM SPEC X TRANS
2970 F(12)=C*B
2980 REM M DRIFT ****************************
2990 N=2 \ GOSUB 650
3000 M(2)=C*B*L1
3010 REM CALCULATE WIND FORCES W/O F(DIRECTION)*************
3020 V(4)=(33/H(1))^(1/7)*V(1)
3030 R2=2.40000E-03
3040 A=.5*R2*(V(4)*1.6835)^2
3050 REM FX WIND *   **   *
```

```
3060 F(14)=A*A(5)
3070 REM FY WIND *   **   *
3080 V(2)=7/8*(H(2)/33)^(1/7)
3090 V(3)=7/8*(H(3)^(8/7)-H(2)^(8/7))/(33^(1/7))/(H(3)-H(2))
3100 C(5)=.92*(V(2)^2*A(2)+V(3)^2*A(3))/(A(2)+A(3))
3110 F(16)=A*(A(2)+A(3))*C(5)
3120 REM M WIND ********************
3130 M(4)=A*(A(2)+A(3))*L1
3140 RETURN
5180 ERASE_TEXT('TEXT') \ MOVE_CURSOR(1,1) \ RETURN
7230 PRINT  \ PRINT  \ PRINT  \ PRINT ,,'PRESS RETURN TO CONTINUE'; \ INPUT D$(7) \ RETURN
32000 END
```

MOUT, tabular output program.

```
10 REM PROGRAM 'STATMOOR' STATIC MOORING ANALYSIS
15 REM BY JAMES V. COX CODE L44 CEL
20 REM   26 AUGUST 1981
21 REM OUTPUT PROGRAM ############################################
22 REM
23 REM
24 REM
25 COMMON F(19),T(6),C(11),M(5),U(3),D(3),A(5),V(4),H(3)
30 COMMON W(6,2),P(6,2),B(4,1),D$(7),B$(1)
35 COMMON R1,P1,T1,D1,L1,S1,N1,B1,H0,E0,E1,E2,M0,M1,T0
40 GO TO 8200
5180 ERASE_TEXT('TEXT') \ MOVE_CURSOR(1,1) \ RETURN
7230 PRINT  \ PRINT  \ PRINT ,'PRESS RETURN TO CONTINUE.'; \ INPUT D$(7) \ RETURN
7250 REM FORCE OUTPUT TABLE ###############################################
7252 A$=''LLLLLLL  'LLLLLLLL  ####,###.   ####,###.   ####,###,###.   ####.##'
7255 PRINT #B,'ENVIRONMENTAL FORCES RELATIVE TO VESSEL AT EQUILIBRIUM'
7257 PRINT #B,'-------------------------------------------------------      LOCAL'
7260 PRINT #B,'                     FX LBS      FY LBS        M FT-LBS      ANGLE (DEGREES)'
7270 PRINT #B,
7280 PRINT #B,USING A$,'CURRENT','FRICTION',F(4)
7290 PRINT #0,
7300 PRINT #B,USING A$,' ','FORM',F(6),F(8),M(0)
7310 PRINT #0,
7320 PRINT #B,USING A$,' ','PROP',F(2)
7330 PRINT #0,
7333 PRINT #B,USING A$,' ','TOTAL',F(7),F(8),M(0),T(1)
7335 PRINT #0,
7340 PRINT #B,USING A$,'WAVES','(MEAN)',F(11),F(13),M(3),T(2)
7350 PRINT #0,
7360 PRINT #B,USING A$,'WIND',' ',F(15),F(17),M(5),T(3)
7370 PRINT #B, \ RETURN
7380 REM COEF OUTPUT TABLE ####################################################
7385 A$=''LLLLLLL  'LLLLLLLL #.###   #.###    ###.   #.###'L  #.###'L #.###  ###.'
7390 PRINT #B,'COEFFICIENT MAXIMUMS'
7395 PRINT #B,'--------------------'
7400 PRINT #B,'                     CXB     CXS     THETAZ   CY      CMB     CMS  THETAM'
7410 PRINT #0,
7420 PRINT #B,USING A$,'WIND',' ',C(4),C(6),T(4),C(5),' ',C(8),' ',C(9),T(5)
7430 PRINT #0,
7440 PRINT #B,USING A$,'CURRENT','FRICTION',C(1),C(1)
7450 PRINT #0,
7460 PRINT #B,USING A$,' ','FORM',.1,.1,0,C(3),'*',C(11),'*'
7470 PRINT #0,
7480 PRINT #B,USING A$,' ','PROP',C(0),C(0)
7490 PRINT #B,
7500 A$='* - INCLUDES ANGLE FUNCTION.    DEPTH/DRAFT FACTOR = #.###'
7505 PRINT #B,USING A$,C(2)
7510 PRINT #0, \ RETURN
7520 REM RESULTS OUTPUT #######################################################
7530 PRINT #B,'STATIC DESIGN RESULTS'
7535 PRINT #B,'---------------------'
7540 PRINT #0,
7550 PRINT #B,'HAWSER LOAD            HAWSER ANGLE            SHIP ANGLE'
7560 A$='####,###. LBS        ####.# DEGREES          ####.# DEGREES'
7565 PRINT #B,USING A$,F(0),T(6),E2
7570 RETURN
8000 REM VIDIO OUTPUT CONTROL ROUTINE ##########################################
8010 GOSUB 5180 \ REM CLEARS SCREEN
8020 PRINT ,,'VIDEO OUTPUT'
8025 B=0 \ REM TERMINAL DEVICE NUMBER
8030 PRINT L$ \ PRINT B$(0)'     'B$(1) \ PRINT L$ \ PRINT
```

```
8040 GOSUB 7380 \ REM COEF
8050 GOSUB 7230
8055 GOSUB 5180
8060 GOSUB 7250 \ REM FORCE
8070 GOSUB 7230
8075 GOSUB 5180
8080 GOSUB 7520 \ REM RESULTS
8090 GOSUB 7230
8095 RETURN
8200 REM OUTPUT FROM MASTER MENU ################################################
8210 GOSUB 5180
8220 PRINT 'VIDEO OR PRINTER OUTPUT (V/P)'; \ INPUT D$(7)
8223 L$='_______________________________________________________________________________'
8230 IF D$(7)='V' THEN  GOSUB 8000
8240 IF D$(7)='P' THEN  GOSUB 9000
8250 CHAIN 'MOOR.BAC' LINE 9000
8260 REM VESSEL OUTPUT ###########################
8270 PRINT #B,'VESSEL INPUT'
8280 PRINT #B,'------------'
8290 PRINT #B,'VESSEL GROUP: 'D$(0)
8300 IF D(1)=4 THEN  GOSUB 8400 \ REM CARGO SUBJECTIVE INPUT
8310 IF D(1)=5 THEN  GOSUB 8450 \ REM TANKER SUBJECTIVE INPUT
8315 PRINT #B,
8320 PRINT #B,'DISPLACEMENT           WATERLINE LENGTH      BEAM          DRAFT'
8325 A$='###,### LONG TONS      ####.## FT            ###.## FT     ##.## FT'
8330 PRINT #B,USING A$,D1,L1,B1,T1
8340 PRINT #B,
8350 PRINT #B,'WIND AREA INPUT (AREAS IN SQUARE FEET)'
8355 PRINT #B,'END                  HULL SIDE          SUPERSTRUCTURE SIDE'
8360 A$='##,###                 ##,###             ##,###'
8365 PRINT #B,USING A$,A(5);A(2),A(3)
8370 PRINT #B,'MAX HEIGHT ABOVE   HULL                 SUPERSTRUCTURE'
8380 A$='WATER LINE         ###.## FT          ###.## FT'
8385 PRINT #B,USING A$,H(2),H(3)
8390 RETURN
8400 REM CARGO
8405 PRINT #B,'SUPERSTRUCTURE   TYPE   LOCATION                            CLUTTERED DECKS'
8410 A$='                 'LL     'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL   'L'
8420 PRINT #B,USING A$,D$(3),D$(4),D$(5)
8430 RETURN
8450 REM TANKER
8460 PRINT #B,'CI TANKER  FULLY BALLASTED  SUPERSTRUCTURE LOCATION             CLUTTERED DECK'
8470 A$=''L           'L                'LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL   'L'
8480 PRINT #B,USING A$,D$(1),D$(2),D$(4),D$(5)
8490 RETURN
8600 REM ENVIRONMENTAL OUTPUT
8610 PRINT #B,'ENVIRONMENTAL INPUT'
8620 PRINT #B,'---  --------------'
8630 PRINT #B,'CURRENT   SPEED           INCIDENT ANGLE     WATER DEPTH'
8640 A$='           ##.## KNOTS     ###.## DEGREES     ####. FT'
8650 PRINT #B,USING A$,V(0),U(1),H1
8660 PRINT #B,
8670 PRINT #B,'WAVE   SIGNIFICANT HEIGHT  PERIOD KNOWN  SIGNIFICANT PERIOD  INCIDENT ANGLE'
8680 A$='       ##.## FT            'LLL           ###.## SEC.         ###.## DEGREES'
8685 PRINT #B,USING A$,H0,D$(6),T0,U(2)
8690 PRINT #B,
8700 PRINT #B,'WIND   SPEED                                       INCIDENT ANGLE'
8710 A$='       ###.## KNOTS AT ##.# FT ABOVE THE WATER    ###.## DEGREES'
8720 PRINT #B,USING A$,V(1),H(1),U(3)
8730 RETURN
9000 REM PRINTER OUTPUT CONTROL ROUTINE ######################################
```

```
9005 OPEN 'LP:' FOR OUTPUT AS FILE 1
9007 B=1 \ REM PRINTER DEVICE NUMBER
9010 PRINT #1,'PROGRAM STATMOOR - STATIC MOORING ANALYSIS'
9030 PRINT #1,DAT$'   'CLK$
9040 PRINT #1,
9053 PRINT #1,B$(0)'   'B$(1)
9056 PRINT #1,L$
9060 PRINT #1,TAB(35);'USER INPUT'
9070 PRINT #1,L$
9080 GOSUB 8260 \ REM VESSEL INPUT
9085 PRINT #1,
9090 GOSUB 8600 \ REM ENVIRONMENTAL INPUT
9095 PRINT #1,L$
9100 PRINT #1,TAB(35);'OUTPUT'
9110 PRINT #1,L$
9120 GOSUB 7380 \ REM COEF
9130 PRINT #1,
9140 GOSUB 7250 \ REM FORCE
9150 PRINT #1,
9160 GOSUB 7520 \ REM FORCE
9200 RETURN
32000 END
```

```
10 REM PROGRAM 'STATMOOR' STATIC MOORING ANALYSIS
15 REM BY JAMES V. COX CODE L44 CEL
20 REM   26 AUGUST 1981
21 REM GRAPHICS OUTPUT PROGRAM *********************************
22 REM
23 REM
24 REM
25 COMMON F(19),T(6),C(11),M(5),U(3),D(3),A(5),V(4),H(3)
30 COMMON W(6,2),P(6,2),B(4,1),D$(7),B$(1)
35 COMMON R1,P1,T1,D1,L1,S1,H1,B1,H0,E0,E1,E2,M0,M1,T0
10000 DIM X(19),Y(19),X2(14),Y2(14)
10010 DEF FNR(X)=X*PI/180
10020 REM DEFINE SHAPES ***********
10030 REM SHIP-HAWSER
10040 FOR N=1 TO 6 \ X(N)=2.5*(N-1) \ X(15-N)=-X(N)
10050 Y(N)=-X(N)^2/6 \ Y(15-N)=Y(N) \ NEXT N
10060 X(7)=X(6) \ X(8)=X(9) \ Y(7)=-100 \ Y(8)=Y(7)
10070 X(0)=0 \ Y(0)=60
10073 X(18)=0 \ Y(18)=20
10076 X(19)=0 \ Y(19)=40
10080 REM ARROW
10170 REM LABLE COORDINATES
10180 FOR N=15 TO 17 \ X(N)=0 \ NEXT N
10190 Y(15)=110 \ Y(16)=123 \ Y(17)=136
10220 REM ROTATE SHIP
10230 T=FNR(E2)
10240 FOR N=1 TO 14 \ GOSUB 10600 \ NEXT N
10250 REM GRAPH SHIP AND HAWSER
10260 WINDOW(,-250,-160,250,160,0)
10265 REGION('FULL',2)
10270 GRAPH('-GRID,LINES',7,X2(1),Y2(1),1)
10275 GRAPH('-GRID,LINES',7,X2(8),Y2(8),,,2)
10277 T=FNR(T(6))
10283 N=18 \ GOSUB 10650 \ POINT(,X,Y)
10287 N=19 \ GOSUB 10650 \ POINT(,X,Y)
10288 N=0 \ GOSUB 10600 \ POINT(,X2(0),Y2(0))
10290 P$=D$(0)+'          '+B$(1)
10300 LABEL(,P$)
10330 REM ADD LABLES TO ARROWS
10335 IF V(0)=0 THEN  GO TO 10365
10340 N=15 \ T=FNR(U(1)) \ GOSUB 10650
10350 MAP_TO_TEXT(X,Y,X,Y)
10360 HTEXT(,X,Y,'C')
10365 IF H0=0 THEN  GO TO 10385
10370 N=16 \ T=FNR(U(2)) \ GOSUB 10650
10375 MAP_TO_TEXT(X,Y,X,Y)
10380 HTEXT(,X,Y,'B')
10385 IF V(1)=0 THEN  GO TO 10420
10390 N=17 \ T=FNR(U(3)) \ GOSUB 10650
10400 MAP_TO_TEXT(X,Y,X,Y)
10410 HTEXT(,X,Y,'W')
10420 REM ANGLE LABLES
10430 MAP_TO_TEXT(0,155,X,Y)
10440 HTEXT(,X,Y,'0')
10450 MAP_TO_TEXT(-160,0,X,Y)
10460 HTEXT(,X,Y,'90')
10470 MAP_TO_TEXT(0,-155,X,Y)
10475 HTEXT(,X,Y,'180')
10480 MAP_TO_TEXT(155,0,X,Y)
10490 HTEXT(,X,Y,'270')
10500 FOR N=1 TO 5 \ PRINT  \ NEXT N
```

```
10505 IF D$(7)='DEMO' THEN  GO TO 10675
10510 PRINT 'PRESS RETURN TO CONTINUE.'; \ INPUT D$(7)
10515 ERASE_GRAPH(,,,0)
10520 CHAIN 'MOOR.BAC' LINE 9000
10600 REM ROTATION ROUTINE
10610 X2(N)=X(N)*COS(T)+Y(N)*-SIN(T)
10620 Y2(N)=X(N)*SIN(T)+Y(N)*COS(T)
10630 RETURN
10650 X=X(N)*COS(T)+Y(N)*-SIN(T)
10660 Y=X(N)*SIN(T)+Y(N)*COS(T)
10670 RETURN
10675 REM DEMO OPTION
10680 PRINT 'WOULD YOU LIKE TO RUN ANOTHER EXAMPLE (Y/N)'; \ INPUT D$(7)
10690 IF D$(7)='N' THEN  GO TO 10515
10700 D$(7)='DEMO' \ GOSUB 10800 \ GO TO 10220
10800 REM INPUT
10805 PRINT 'INCIDENT CURRENT ANGLE IN DEGREES = '; \ INPUT U(1)
10810 PRINT 'INCIDENT WAVE ANGLE IN DEGREES = '; \ INPUT U(2)
10820 PRINT 'INCIDENT WIND ANGLE IN DEGREES = '; \ INPUT U(3)
10830 PRINT 'VESSEL ANGLE IN DEGREES = '; \ INPUT E2
10840 PRINT 'HAWSER ANGLE IN DEGREES = '; \ INPUT T(6)
10845 ERASE_TEXT
10850 RETURN
32000 END
```

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